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The higher the educational level of the first-time mother, the lower the fetal and post-neonatal but not the neonatal mortality in Belgium (Flanders)

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ABSTRACT

Objective: To assess, in a homogenous population of primiparous women, how fetal and infant (=first year of life) mortality varied by the mothers' level of education.
Study design: We conducted an observational study in Flanders (Northern Belgium) involving 170,948 primiparous women who delivered in Flanders during the period 1999–2006, and their 174,495 babies. We linked the maternal education (3 levels) with a series of obstetrical and perinatal events, with special emphasis on fetal and infant death. A logistic regression analysis was performed to adjust for confounders.
Results: The incidence of fetal (0.21% – high level of education; 0.35% – medium level; 0.84% – low level) and infant mortality (0.32%; 0.41%; 0.70%, respectively), followed an inverse maternal educational gradient: higher with a lower level of education. However, neonatal death (0–27 days) was independent of the educational level of the mother. The age of the woman at delivery, the use of assisted reproductive technology and the incidence of twin birth increased while the rates of preterm birth (7.7% – high level; 8.9% – medium level; 10% – low level) and low birth weight (7.2%; 9.5%; 11.8%, respectively) decreased with the mother's educational level.
Conclusion: Perinatal and obstetrical outcome differ according to the level of the education of the mother, which is a determinant of the incidence of fetal and post-neonatal death but not of early and late neonatal death (0–27 days).

1. Introduction

Perinatal death is predominantly the result of preterm birth [1] which is not only influenced by biological (infection, vascular disease), behavioural (smoking, alcohol, drugs) and genetic factors, but is also a social disease [2]. Educational and income levels of the mother correlate with birth outcome in developed countries [3–7] but controversies exist [8]. We wondered to what extent differences in the maternal level of education accounted for differences in fetal, neonatal and post-neonatal death and in the course of pregnancy in a homogenous group of Flemings with equal access to healthcare. To that end, we conducted an observational, birth cohort-based study.

2. Patients and methods

Every person residing legally in Belgium must have individual health insurance which is provided by private medical insurance companies that are strongly regulated by the government. The federal government controls and refunds healthcare, and takes responsibility for the general access to healthcare, including obstetric care.

Flanders (the Dutch speaking Northern part of Belgium with six million inhabitants) has 68 fully equipped maternity–obstetric units, of which four are in university hospitals, 17 in hospitals with training facilities and 47 in community hospitals. Ninety-eight percent of the women receive prenatal care from a gynaecologist affiliated to a maternity unit. There are on average 62,000 births per year. Almost all (99%) deliveries take place in the 68 units.

All of the following data were derived from the computer files of the Study Centre for Perinatal Epidemiology (SPE). The SPE is an independent and regionally funded centre that registers all births of ≥500 g that took place in the 68 obstetric units. For each

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newborn, a standard perinatal form containing 32 obstetric and 20 neonatal items is completed and sent to the SPE, where all data are checked by an error detection programme and feedback is given. The perinatal data are linked, by means of a common code, to the socioeconomic data of the mother. The latter data are collected by the district councils following the birth. During the study period (01.01.1999–31.12.2006) 497,570 babies were born. We limited our study to primiparous Flemish women. The choice of primiparity was to avoid the possibility that the educational level of a woman who delivered on more than one occasion during the study period would have been counted more than once. We excluded 9% of pregnant women with an unknown level of education, 1% home births, and 13% women belonging to ethnic minorities (8% Moroccans and Turks and 5% others). As a result, a homogeneous group of 170,948 (77% of all primiparous) women, who delivered 174,495 babies of at least 500 g, were included.

"Maternal education" was used as an index of socioeconomic status and we distinguished three levels according to the highest diploma obtained by the woman. High level = high grade diploma, master or bachelor degree, minimum 15 years of education. Medium level = middle grade diploma, higher degree, 12–14 years of education. Low level = no diploma or a low or middle grade lower degree diploma, maximum 11 years of education.

Caesarean section can be performed either pre-labour (elective) or after spontaneous or induced labour. Fetal death accounts for a stillborn baby. Infant mortality is the sum of early neonatal (0–6 days–23 h–59 min), late neonatal (7–27 days–23 h–59 min) and post-neonatal (28–365 days) death. Neonatal morbidity pertains to the sum of the incidence of intracranial haemorrhage, convulsions, endotracheal intubation, lung disease and/or infections.

To avoid the possibility that baseline characteristics would influence each other, we carried out a logistic regression analysis. The outcome variables were fetal death, neonatal (early + late) and post-neonatal death. For fetal death, the mother's education, maternal age, living conditions (alone or with partner), assisted reproduction technology (ART) and twin pregnancy were included into the equation. For neonatal and post-neonatal death, the aforementioned variables were completed with labour induction and emergency caesarean versus vaginal delivery. We stratified the outcome of the regression analysis according to congenital malformation, preterm birth and low birth weight.

Statistical analysis was carried out with SPSS (V15.0, SPSS Inc.). Univariate comparison of categorical variables was done with the Fisher's exact test. The non-parametric Mann–Whitney *U*-test was used to compare continuous variables. Also logistic regression analysis was performed to determine the dependence of some of the explanatory variables on the outcome of the newborn. The significance was set at alpha = 0.05, two tailed.

3. Results

The distribution of the studied population according to educational background was: high level = 49.3%, medium level = 42.8% and low level = 7.9%. From 1999 to 2006, the percentage of high level education rose from 44.5% to 52.3%, that of medium level decreased from 44% to 40% and that of low level from 10.4% to 6.9%.

The new mothers were predominantly 'employees/civil servants' (66%) and less frequently 'manual workers' (17%). Seven percent had an 'independent/managerial' occupation and another 7% had 'no profession'. Manual workers were over-represented in the group with the lowest level of education, whereas 'employees' mostly were women with a high level of education (Table 1). Single, non-cohabiting women were over-

Table 1
Maternal level of education in relation to maternal and perinatal characteristics.

	High	Medium	Low	Chi-square 2×3
Maternal educational level				
N women	84,249	73,112	13,587	
N babies	86,169	74,552	13,774	
Maternal professional status: % (number)				
Independent managerial	7.6 (6,382)	6.3 (4,597)	3.8 (519)	*
Employee (white collar)	82.4 (69,411)	54.1 (39,525)	24.7 (3,360)	*
Manual worker (blue collar)	1.8 (1,508)	30.3 (22,141)	44.4 (5,897)	*
No profession	1.7 (1,467)	8.7 (6,350)	26.3 (3,575)	*
Maternal characteristics: % (number)				
Non-cohabiting	4.5 (3,755)	9.6 (7,009)	19.2 (2,609)	*
Mean age (year) (SD)	29.3 (3.3)	27.0 (3.5)	25.1 (5.1)	*
Age <20 years at delivery	0	3.8 (2,748)	17.2 (2,343)	*
Age ≥35 years at delivery	6.7 (5,637)	4.9 (3,612)	5.4 (735)	*
Pregnancy after ART	7.6 (6,429)	5.6 (4,086)	4.1 (559)	*
Twin birth	2.3 (1,918)	1.9 (1,417)	1.4 (193)	*
Induction of labour	27.5 (23,166)	31.6 (23,074)	34.8 (4,598)	*
Caesarean section	18.8 (15,853)	20.8 (15,209)	20.4 (2,777)	*
Preterm birth <32 weeks	0.8 (711)	1.1 (831)	1.7 (232)	*
Preterm birth 32–<37 weeks	6.9 (5,793)	7.8 (5,720)	8.3 (1,134)	*
Preterm birth: iatrogenic	2.7 (2,313)	3.4 (2,464)	3.7 (508)	*
Preterm birth: spontaneous	5.0 (1,649)	5.6 (4,087)	6.3 (858)	*
Perinatal characteristics: % (number)				
Weight <1500 g	1.0 (904)	1.4 (1,041)	2.2 (302)	*
Weight 1500–2500 g	6.2 (5,362)	8.1 (6,040)	9.6 (1,322)	*
Weight ≥4000 g	6.9 (5,925)	5.3 (3,973)	4.0 (556)	*
Fetal death	0.21 (183)	0.35 (259)	0.84 (116)	*
Fetal death (-con mal)	0.19 (164)	0.32 (238)	0.77 (106)	*
Early neonatal death (0–6 days)	0.17 (148)	0.22 (161)	0.33 (45)	*
Early neon. death (-con mal)	0.13 (113)	0.15 (112)	0.25 (34)	0.004
Late neonatal death (7–27 days)	0.06 (50)	0.07 (51)	0.09 (12)	NS
Post-neonatal death (28–1 years)	0.09 (75)	0.12 (87)	0.28 (39)	*
Neonatal morbidity	5.3 (4,568)	5.7 (4,249)	6.4 (874)	*

N: number, ART: artificial reproductive technology, con mal: congenital malformations.
* 3×2 chi-square $p < 0.001$.

Table 2
Birthweight-specific fetal and infant mortality rates according to the maternal educational level.

	Maternal educational level			
	High level	Medium level	Low level	Chi-square 2 × 3
N birthweight ≥2500 g	79,903	67,471	12,150	
Fetal † (‰)	59 (0.7)	60 (0.9)	25 (2.1)	$p < 0.001$
Neonatal † 0–27 days (‰)	58 (0.7)	58 (0.9)	16 (1.3)	$p = 0.10$ (NS)
Post-neonatal† 28–365 days(‰)	49 (0.6)	59 (0.9)	22 (1.8)	$p < 0.001$
N birthweight <2500 g	6,266	7,081	1,624	
Fetal † (‰)	124 (19.8)	199 (28.1)	91 (56.0)	$p < 0.001$
Neonatal † 0–27 days (‰)	140 (22.8)	154 (22.4)	41 (26.7)	$p = 0.58$ (NS)
Post-neonatal † 28–365 days(‰)	26 (4.2)	28(4.0)	17 (11.1)	$p < 0.01$

N = number, † = death.

whelmingly found among those having the lowest educational background (Table 1).

Maternal age at delivery, the use of ART and twin births showed an educational gradient (Table 1). Caesarean section and labour induction (Table 1) were lowest in those with the highest education. The incidence of preterm birth (iatrogenic or spontaneous), low birth weight, neonatal morbidity, and fetal and infant death, also followed an educational gradient: these outcomes were least common among those women having the highest level of education (Table 1). The aforementioned gradients were observed in each of the three categories of hospitals (community, teaching and university) separately.

We collected 1226 deaths: 558 fetal, 354 early, 113 late and 201 post-neonatal deaths, of which 67% occurred in babies with a birth weight <2.5 kg and 33% in babies with a birth weight >2.5 kg. The fetal death rate is significantly associated with the education of the mother irrespective of the birth weight (Table 2). Neonatal (early + late) deaths are not associated with the maternal educational level (Table 2).

The perinatal mortality improved slightly between 1999 (0.70%) and 2006 (0.63%). The decline was highly significant among women featuring the highest level of education (0.53% in 1999 and 0.37% in 2006; $p = 0.000$, chi-square) but was not seen among those with a low educational level (1.36% in 1999 and 1.44% in 2006) (SPE Annual Reports 1999–2006).

After stratification for congenital malformations, preterm birth and low birth weight, fetal death was significantly and independently determined by maternal education (high versus low): O.R. 0.29 (0.17–0.50) and by maternal age (<20 years versus ≥35 years): O.R. 7.6 (1.7–34.4). For neonatal death, the logistic regression analysis failed to find any statistically significant determinant. After stratification for the above mentioned determinants, post-neonatal death was significantly and independently related to maternal age and education (high versus low maternal education: O.R. 0.35 (0.19–0.67); medium versus low maternal education: O.R. 0.53 (0.30–0.94); maternal age <20 year versus ≥35 years: O.R. 2.27 (1.09–4.76)). In other words: more fetal and post-neonatal death was encountered in the younger and the less educated women.

4. Discussion

In a homogeneous population of Flemish primiparous women, we found that the incidences of preterm birth, low birth weight, and fetal and infant mortality were lowest among those with the highest education. The link between maternal education and fetal/neonatal demise has been investigated especially in Scandinavian countries [3,5,6]. Bakketeig et al. [5], comparing three Nordic countries, found that fetal and infant mortality was greater with less than 8 years of education. According to Stephansson et al. [3], fetal death affects Swedish women with the lowest socioeconomic status more than twice as often as women belonging to the highest stratum. In Oslo, maternal education of less than 10 years' duration was associated with a nearly fourfold increase in unexplained fetal and infant mortality [6]. In the population we studied, fetal death was four times more frequent in the group of women with the lowest educational background when compared with those with the highest educational credentials. Fretts [7], in a systematic review of fetal death risk, found that low educational attainment (<12 years), beside nulliparity, ethnicity, advanced maternal age, obesity, smoking >10 cigarettes/day among others, was an independent risk factor for fetal death. However, perinatal data collected routinely in three hospital trusts in London did not show social disadvantage – unlike preterm birth and low birth weight – to have direct impact on fetal and early neonatal death [8].

A review by Kramer et al. [9] revealed that maternal educational gradients were related to the occurrence of preterm birth and low birth weight not only in the Nordic countries but also in the USA, Canada and the Czech Republic. Thompson et al. [10] found that the preterm birth rate in Norway was similarly affected. In the Trent health region, UK, women of the most deprived decile were at nearly twice the risk of very preterm birth compared with those from the least deprived decile [11]. In Flanders, the risk of very preterm birth among women with a low level of education was twice that of women with a high level.

Early and late neonatal mortality, unlike fetal death, is in Flanders independent of the educational level of the mother. This is probably due to the readily available and considerably improved neonatal intensive care that attenuates the role of education-dependent maternal behaviour. Before the era of neonatal intensive care, there used to be a strong correlation [12].

However, post-neonatal (28–365 days) mortality in Flanders is more closely linked to the mother's educational level and to her living conditions. Here medical care has a lower impact and maternal factors (such as smoking, being single, depressed, unemployed or with unfavourable working conditions) may adversely affect the infant [13]. The overall low infant mortality in Flanders, as in many other developed regions, is also the result of campaigns during the 1990s for the prevention of sudden infant death syndrome (SIDS) which led to a dramatic decline in SIDS [14]. However, SIDS is much affected by socioeconomic disparity: it is more frequent among those with a low educational attainment.

The welfare and the level of education of the population in developed countries have been rising for several decades. Currently, half of the primiparous Flemish women are highly educated. Among the less than 10% of Flemings of low educational level, the offspring did not fare better over time. Arntzen et al. [15] found that the welfare and educational level in Norway significantly improved between 1968 and 1991: the proportion of women with the lowest level had decreased from 56.3% (1968–1971) to 10.7% (1989–1991). But, as in Flanders, not every social group had benefited by the greater welfare: low educational level and post-neonatal mortality were even more closely linked than

before [15]. Between 1981 and 2000, this latter observation still held not only for Norway but for all the Nordic countries: there was a further decline in infant mortality in all educational groups but a more pronounced inverse association between post-neonatal mortality and the maternal level of education [16]. Singh and Kogan came to a similar conclusion with regard to the USA: although a dramatic decline in infant mortality occurred among all socioeconomic groups during 1969 and 2001, the socioeconomic disparity still exists and has even increased [17]. Health gradients are here to stay and less educated people will generally fare worse [4]. But, by reducing the percentage of the less educated women further, the global health of the population will improve and a small, but more seriously vulnerable, socioeconomic group may be defined for which special healthcare attention should be given.

The gradient in fetal/infant demise according to the level of education is mainly the result of differences in the occurrence of preterm birth, low birth weight and congenital malformations. These, in turn, are partly associated with behaviours and factors influencing adverse birth outcomes such as smoking, substance abuse, working conditions, promiscuity, clinical depression/anxiety, being single, overweight and obesity, maternal age, different recourse to prenatal care, effect of the neighbourhood, psychological or social stress and also gene–environment interactions [2,4,13,18–24].

Undoubtedly, the major shortcoming of this study is the lack of information on the smoking habits of our pregnant population. Although smoking among pregnant women in the developed world has importantly declined during the past 20 years, it still accounts for a significant fetal (20–30% increase in fetal death) and infant (40% death increase and a doubling of SIDS) mortality and morbidity (impaired fetal growth, placental abruption) [19]. The effects of smoking in pregnancy on the surviving offspring are probably life-long [20]. Behavioural support with smoking cessation is the only intervention that has been proven to modestly reduce smoking rates in late pregnancy [21]. A random sample in 2002 showed that 17% of the Flemish pregnant women have ever smoked during pregnancy and 10% smoked 10 cigarettes or more/day, but no distinction between the educational levels was made.

Another shortcoming of this study is that we have the timing of the first antenatal visit only for 2001. In that year and according to the educational level, 65% (lowest level), 76% (medium level) and 79% (highest level) of the pregnant women respectively were booked for prenatal care before the end of the first trimester. Studies in 10 European countries found an association between women with less education and low income and inadequate prenatal care. Having no health insurance was the dominant reason for not submitting to antenatal care [25]. Another reason for differences in offspring outcome may be a social class difference in reacting to signs and symptoms of a pathological pregnancy [3], but also physicians may be more capable of apprehending worrying signs in the better educated woman.

The level of education of the mother was directly related to her age, to the use of ART and to twin births. Better educated women wait longer to become pregnant, are faced with a decline in fertility, need more ART and are therefore more at risk of multiple pregnancies [26]. Women with the highest education had the lowest frequency of labour induction and caesarean section. This was also found in a Norwegian cohort study [27]. As expected, with a decreasing level of education, there is an increasing obstetrical vulnerability. In Canada, caesarean section and labour induction were no more frequent among affluent women when controlled for all relevant risk factors [28].

To conclude: In Flanders, the level of maternal education is related to fetal and post-neonatal death but not to early and late neonatal demise. This study emphasizes that, even in a region with universal health coverage, equality in access to obstetric/perinatal care does not lead to equality in obstetric/perinatal outcome. Health disparities still subsist.

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